Space Weather Technical Forecast

Issued on Monday, 23 September 2024 at 13:12 Local

From the 24th of September, the way we distribute this forecast is changing and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic Storm intervals, mainly day 3 (25 Sep) due to coronal hole high speed stream and a possible glancing blow CME. Chance of M-flares (R1-R2 Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with one long duration M-class flare observed, peaking M3.7 at 22/2139 UTC. This was from a filament eruption on the southeast disc, located between AR3834 and AR3835, both appear to be small and simple. Otherwise the main development out of the seven sunspot regions currently on the disc was in AR3833 on the northwest disc, with the formation of a small delta spot within its intermediate spots, but also the decay of its leader and trailer spots. AR3828 persists as the next most complex region, as a mature main spot with surrounding small but developing and decaying peripheral spots. The other regions are smaller and simpler, although some magnetic looping evident on SDO imagery on the southeast disc indicates a new region which is currently emerging on the east limb. This will be analysed as soon as it moves into a better viewing angle.

The filament eruption that produced the M3.7 produced a CME, which has been observed in SOHO LASCO C2 imagery. This is directed primarily to the south and east, away from Earth, however, analysis results suggest a possible glancing blow on Day 3 (25 Sep), possibly from the 'shock' associated with the CME. If this occurs, it would also coincide with the arrival of a HSS from CH72/+. However, this is low confidence. No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: Slow wind conditions persisted. Solar wind speeds, as observed by ACE at L1 declined from slightly elevated levels, with a peak of 440km/s, to be at background levels, near 350km/s. Density was mainly below average. Interplanetary Magnetic Field, Bt, was weak throughout at 5-9nT, with its north-south component, Bz, remaining weak, between +6nT and -7nT, and favouring a positive (northward) direction. Phi angle has been predominately negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at Background. High energy electron flux (greater than 2MeV) observed by GOES16 was mainly Moderate at first, but rose to be High from 22/0950 UTC, peaking at 2340 pfu at 22/1435 UTC. The associated 24-hour fluence rose above Active (1e8 total pfu) by the 22/1800 UTC observation. The 23/0000 UTC observation was 1.13e8 total pfu.

Four-Day Space Weather Forecast Summary

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Met Office Space Weather Technical Forecast

Solar Activity: Low to Moderate activity is expected, with a chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: The partial halo CME which was observed following the M3.7 flare off the southeast quadrant has been analysed. Results suggest a possible glancing blow on Day 3 (25 Sep), probably associated with the 'shock' as the bulk of the material appears to be heading to the south and east of Earth's orbit. However, this is considered low confidence.

Slow wind conditions are expected to persist days 1-2 (23-24 Sep) before the onset of any CIR and fast wind from CH72, most likely day 3 (Sep 25), which could possibly coincide with the glancing CME from the M-class flare on 22 Sep. Solar winds are likely to become elevated, only gradually easing late day 4 (Sep 26). Mainly Quiet (Kp 0-2) geomagnetic activity at first with a chance of isolated Unsettled (Kp 3) intervals. The CIR and onset of CH72/+ fast winds will then bring a likelihood of Active to G1/Minor Geomagnetic Storm intervals, perhaps later day 2 (24 Sep), but most likely day 3 (25 Sep). If the coronal hole fast wind coincides with the glancing blow CME, geomagnetic activity could be more enhanced, although this is low confidence. Otherwise, activity easing to Quiet to Unsettled, with Active intervals on day 4 (26 Sep).
No other Earth-directed CMEs feature in the forecast.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is expected to remain at Background. High energy electron flux at GOES16 is expected to be Moderate to High days 1-2 (23-24 Sep) with the associated 24 hr fluence persisting at Active (1e8 total pfu). Confidence falls by day 3 (25 Sep) however due to the potential onset of CH72 fast winds, or possible glancing CME, although a recovery in flux and subsequent fluence is likely as any initial enhancement eases on day 4 (26 Sep).

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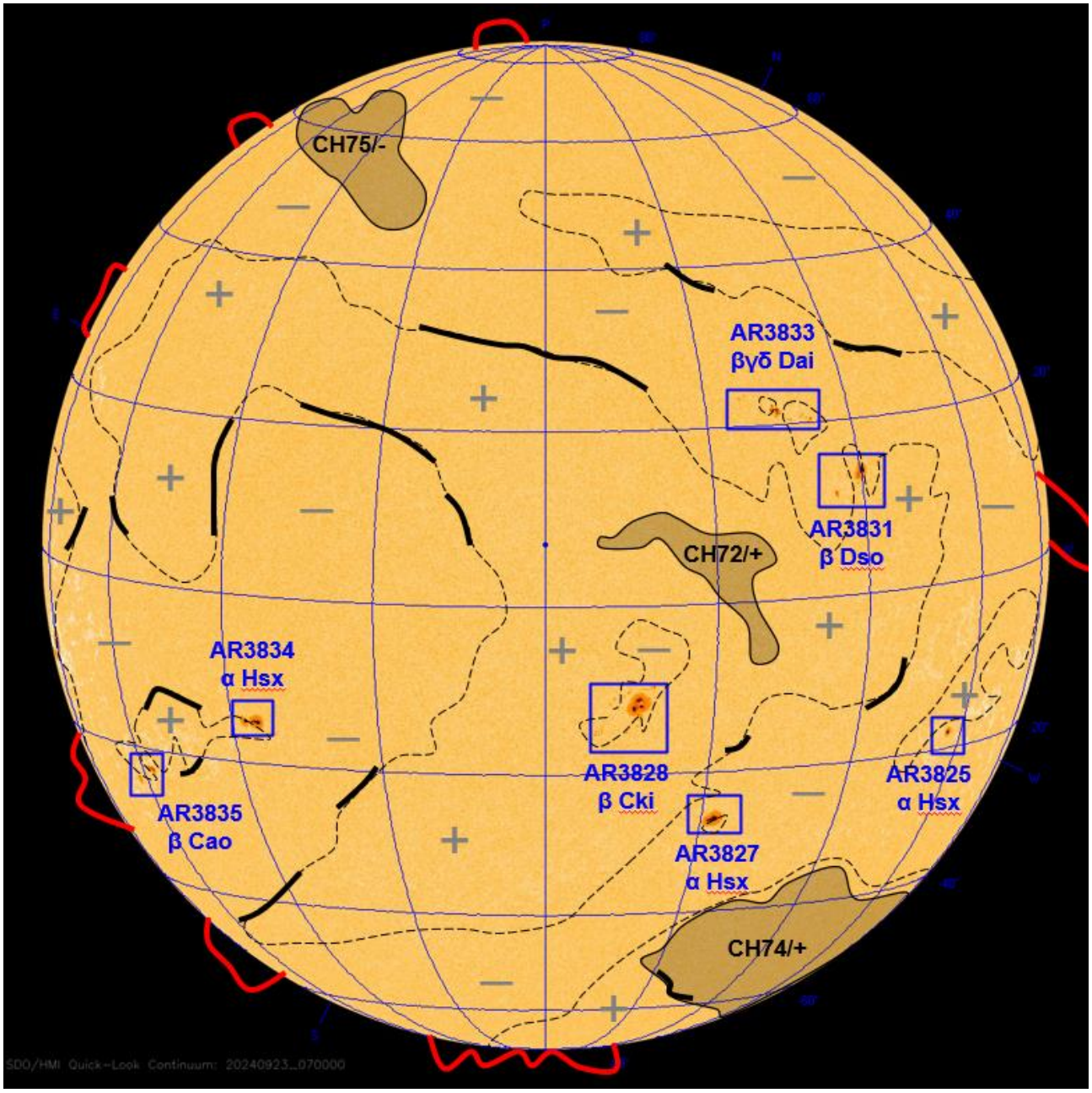
Figure 1. Solar Analysis Valid 23/0700 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
The partial halo CME which was observed following the M3.7 flare off the southeast quadrant has been analysed. Results suggest a possible glancing blow on day 3 (25 Sep). The bulk of the material appears to be heading to the south and east of Earth's orbit. However, a possible 'shock' ahead of the CME could possibly glance Earth. This may coincide with the arrival of any CIR or connection to the fast wind from CH72/+. However, this is aspect of the forecast is considered to be low confidence.

Slow wind conditions, with mainly background speeds are expected to persist until the arrival of any CIR and connection to the fast wind from CH72/+, currently central disc, and possibly a glancing blow from a CME (or associated shock). This activity is currently anticipated later day 2 (24 Sep), or more likely, on day 3 (25 Sep).

The coronal hole is a persistent feature and is in a generally similar location when compared to previous rotation, but is more defined and extends slightly further west on this occasion. Alongside the coronal holes positive polarity and the proximity of the September Equinox, this would suggest a stronger response and greater possibility of geomagnetic enhancement than persistence would indicate. MOSWOC Enlil suggests a slight rise in winds towards the end of the period, but is considered to be too low with forecast values, with solar winds of around 500-550 km/s currently expected. However, this may coincide with the possible arrival of a 'shock' from a partial halo CME, which left the Sun on 22 Sep. The bulk of the CME is expected to miss Earth, behind our orbit, with a possible glance from the 'shock' ahead of the CME. However, this is considered low confidence.

Geomagnetic activity is forecast to be mainly Quiet (Kp 0-2) at first with a chance of isolated Unsettled (Kp 3) intervals. The CIR and onset of CH72/+ fast winds will then bring a likelihood of Active to G1/Minor Geomagnetic Storm intervals later day 2 into day 3 (24-25 Sep). However, if this coincides with a possible glancing CME (from 22 Sep), geomagnetic activity could become more significantly enhanced on days 3-4 (25-26 Sep), possibly reaching G2-G3/Moderate-Strong storm, especially as we are near the Equinox. This is currently considered to be low confidence. Geomagnetic activity is more likely to gradually ease to Quiet to Unsettled, with Active interval on day 4 (26 Sep).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	1	20	60	5
Strong	**G3**	No	1	1	5	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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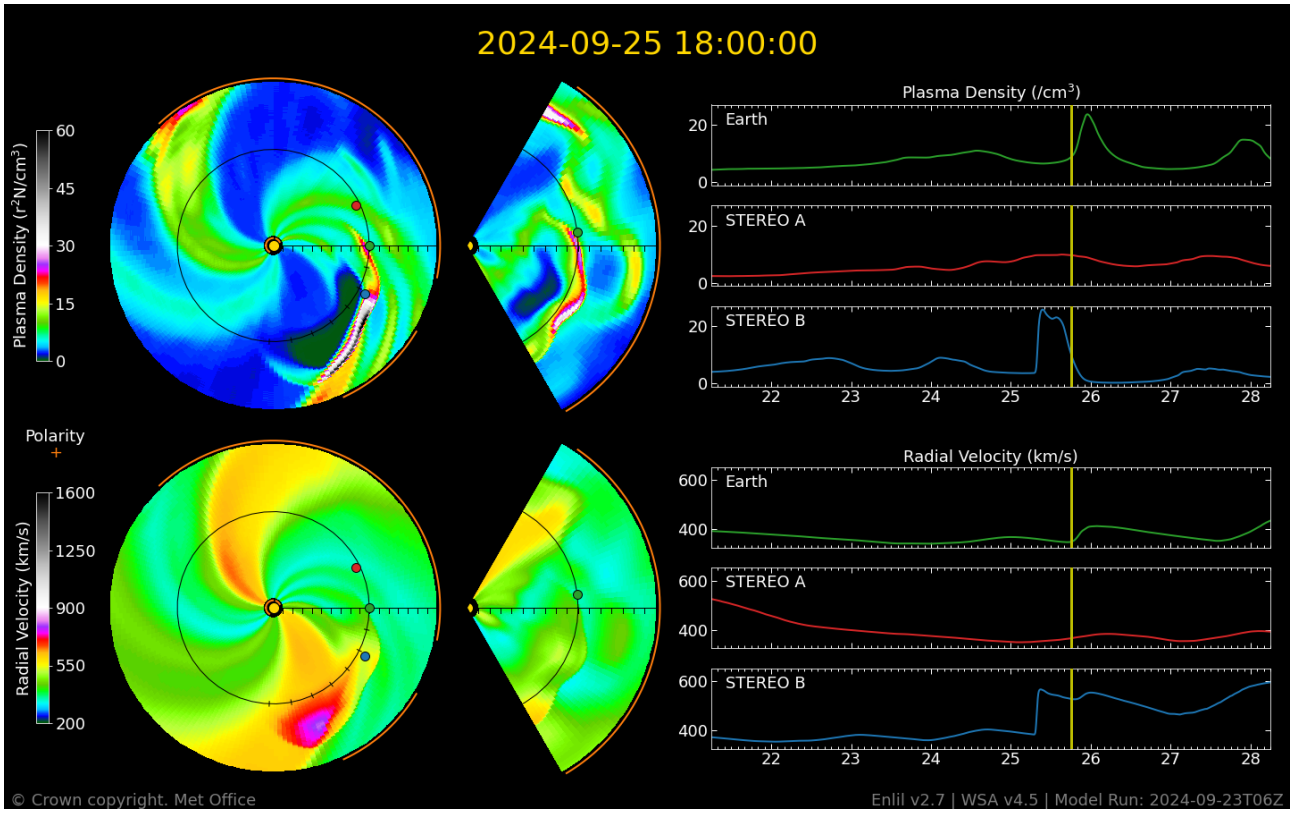
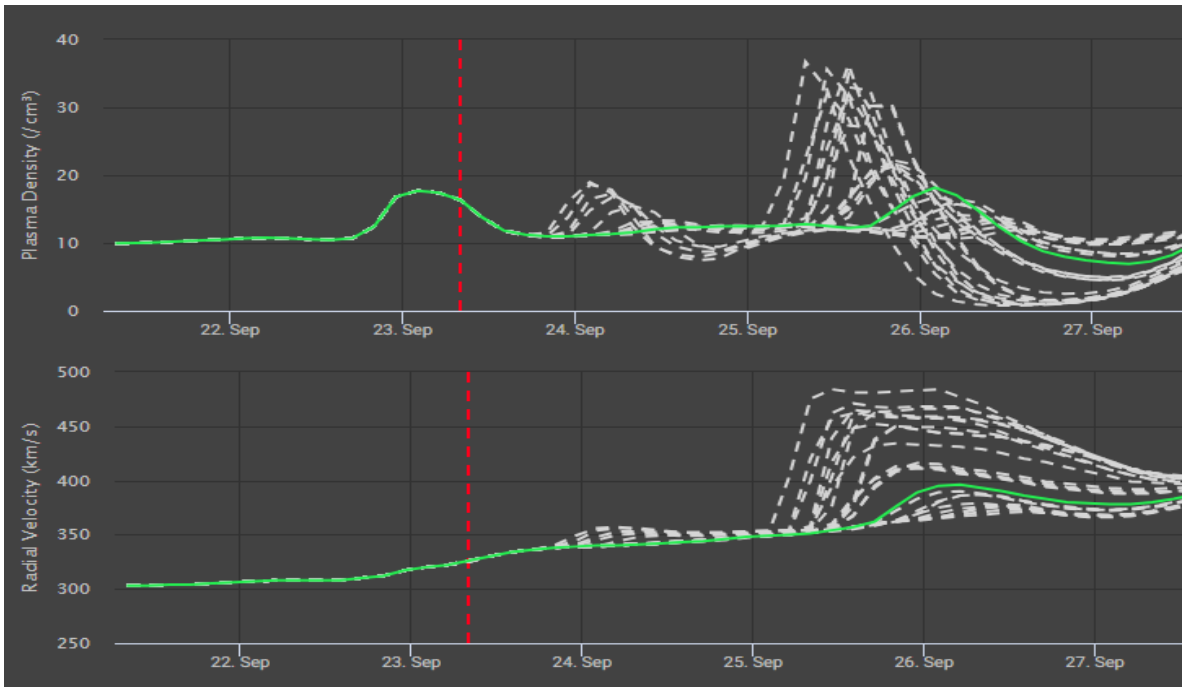
Figure 2: MOSWOC ENLIL and Ensemble shows a possible glancing blow from a CME, which left the Sun on 22 Sep, arriving on 25 Sep. Low confidence. Note: Enlil is currently missing any fast wind from CH72, which is also forecast to arrive either late 24 Sep, more likely on 25 Sep, which could coincide with the possible glancing CME.





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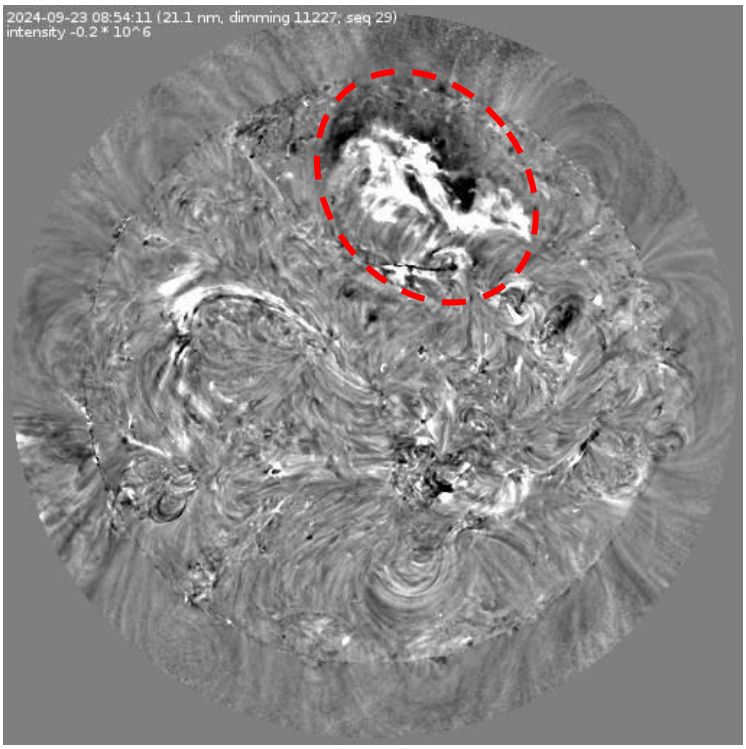
Radio Blackouts - X-Ray Flares:
Moderate to Low activity is expect with an ongoing chance of M-class flares. There are currently seven sunspots on the visible disc, however the only M-class flare in the last 24 hours was associated with a filament eruption, from a plage area between AR3834 and AR3835. There are further large filaments on the disc, and similar eruptions are possible.

A dimming event took place in the northwest quadrant at 23/0745 UTC, which was associated with a minor filament eruption. The bulk of the material, as seen in GONG imagery, appeared to be moving off to the north and west. Awaiting further coronagraph images for any possible CME associated with this event.

Figure 3: Dimming intensity from SDO/AIA 211 imagery. Shows a dimming event in the NW quadrant (red circle), possibly associated with a small filament lift-off. No CME evident in coronagraph imagery.



Of the visible regions AR3833 in the northwest is perhaps the most likely of these to flare, despite its small size. This is due to the formation of a weak delta spot within its intermediate spots, which has become the main feature of this region with the leader and trailer spots now fading. AR3828 is also of note, persisting as a mature region with a central large central spot, but with a number of mixed polarity peripheral spots that continue to vary in development. The other regions are largely small and simple.

A further possible flare source is a potential new region that is on the southeast limb, evidenced by some bright and significant looping on SDO aia-94 imagery, which is now just becoming visible on the limb. This is likely associated with a strong signal on helioseismic imagery, and will gradually become more visible over the coming day or two.

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X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: GOES16-18 X-ray flux.

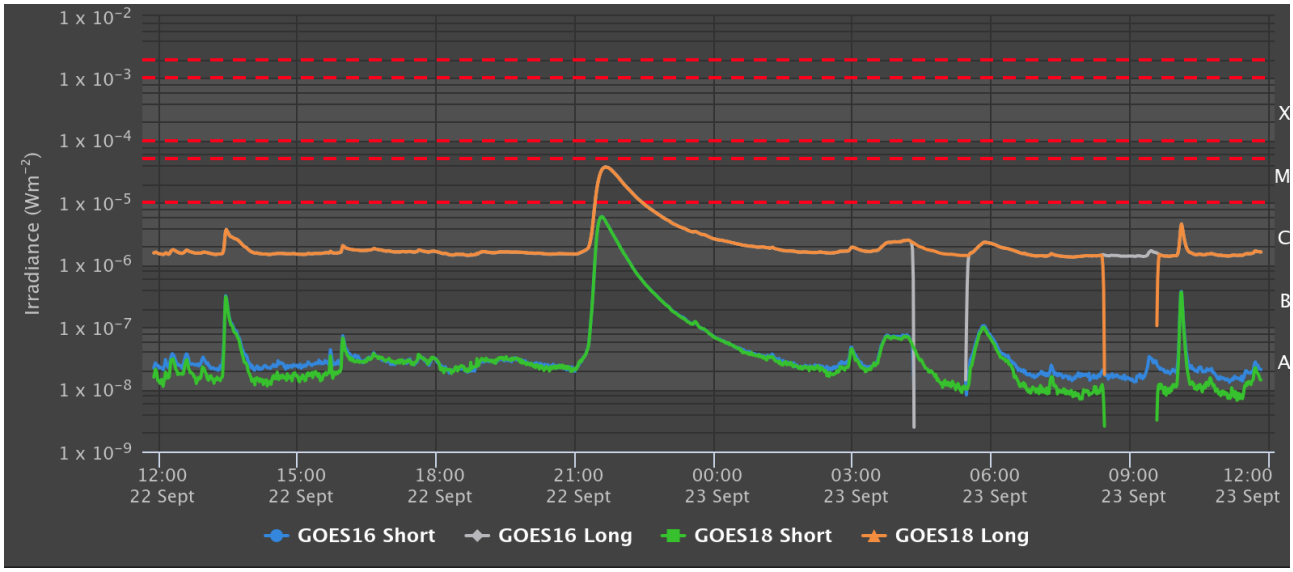
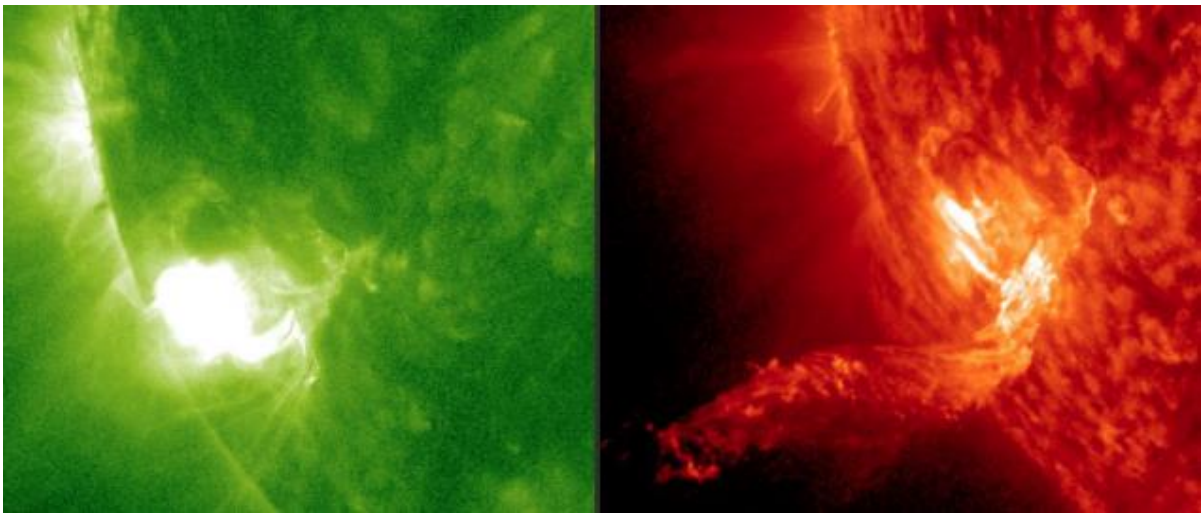


Figure 4b: SDO aia-94 (left) and SDO aia-304 (right) of filament eruption. Likely new region over SE limb also visible in imagery



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux at GOES18 is forecast to persist at background, with only a very slight chance of rising to S1 Minor Radiation Storm.

The majority of the sunspots on the disc either small, simple or declining. However the slight complexity apparent in AR3833 in the northwest and AR3828 in the south-centre results in a very slight chance of proton productive flares. There is also a non-zero, albeit very low chance of observable protons from any significant filament eruption, given the number and size of notable filaments currently on the disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

GOES-16 high energy electron flux has varied between Moderate and High, likely as a consequence of the outward expansion of the enhanced electron populations at lower orbits from the CME arrival on 16-17 Sep. Flux is expected to continue varying at this level though days 1-2 (23-24 Sep), before the onset of any fast wind from coronal hole 72, or a possible glancing blow (shock) from a CME, most likely on day 3 (25 Sep). The subsequent increased solar wind pressure will likely compress the Van Allen belts, with a drop out in observed values, possibly on day 3 (25 Sep) more likely on day 4 (26 Sep).

The associated 24 hour fluence subsequently reached the Active level, and is likely to persist at this level through days 1-2 (23-24 Sep). Confidence then falls days 3-4 (25-26 Dec) due to the likely drop out of flux due to onset of any fast wind of CH72/+, in the centre-disc, and possibly the arrival of a glancing CME (from 22 Sep).

MOSWOC REFM also suggests a natural declining trend to the fluence, however this has been consistently underestimating the observed fluence reducing confidence in this model guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	70	40	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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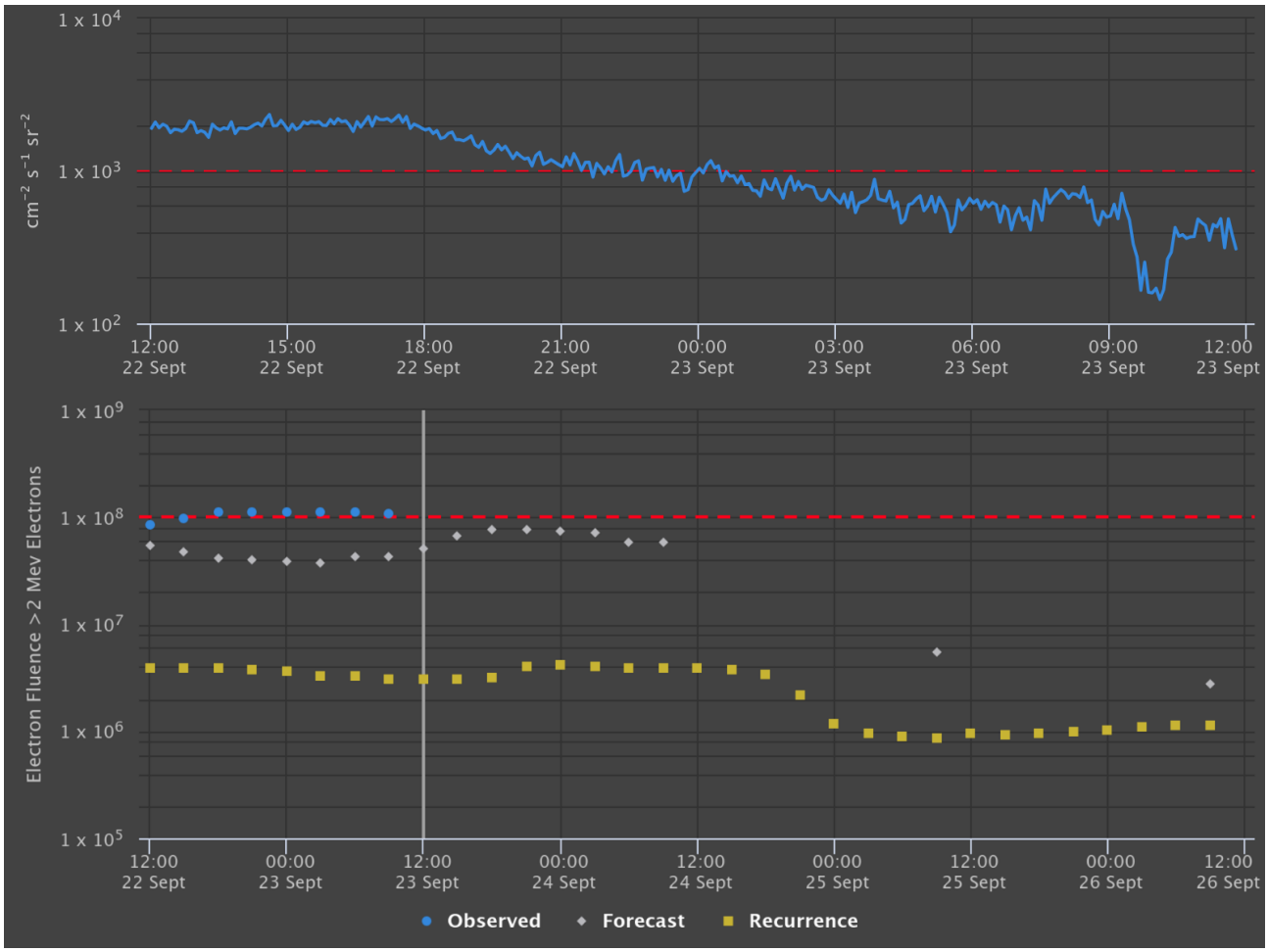
Figure 5: GOES16 >2 MeV Electron Flux (top) and the 24 hour electron fluence with REFM (bottom).



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